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AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE CHEMISTRY

H

Higher Tier Paper 1

Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:
- a ruler
- a scientific calculator
- the periodic table (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	

Information

- The maximum mark for this paper is 100.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

J U N 2 2 8 4 6 2 1 H 0 1

IB/M/Jun22/E10

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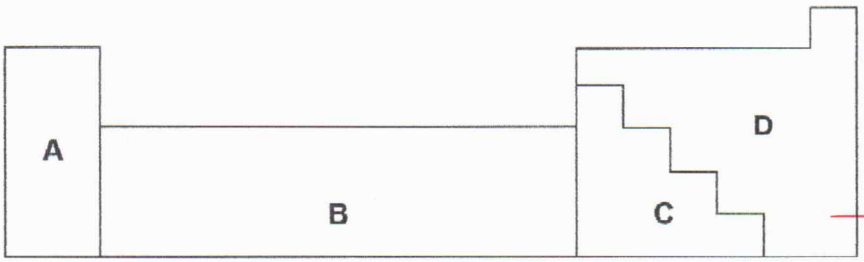
0 1 This question is about metals and non-metals.

Figure 1 shows an outline of part of the periodic table.

Figure 1



A B and C → Metals

Non metals
- Dull
- Does not Conduct electricity

0 1 . 1 Element **Q** is a dull solid with a melting point of 44 °C.

Element **Q** does not conduct electricity.

Which section of the periodic table in **Figure 1** is most likely to contain element **Q**?

[1 mark]

Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☑

0 1 . 2 Element **R** forms ions of formula R^{2+} and R^{3+}

- Transition metals have various oxidation states.

Which section of the periodic table in **Figure 1** is most likely to contain element **R**?

[1 mark]

Tick (✓) **one** box.

A ☐ B ☑ C ☐ D ☐

0 1 . 3 Give **two** differences between the physical properties of the elements in Group 1 and those of the transition elements.

[2 marks]

1 Group 1 are soft metals while transition metals are harder

2 Group 1 have lower densities than transition metals

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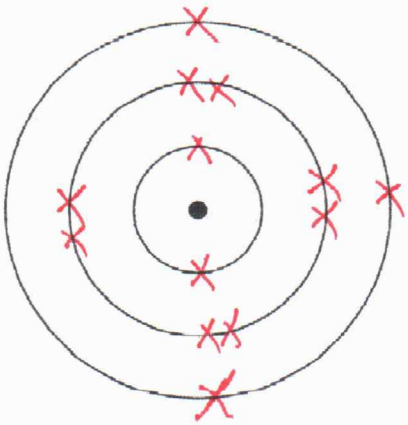
0 1 . 4 Complete **Figure 2** to show the electronic structure of an aluminium atom.

Use the periodic table.

[1 mark]

Figure 2



0 1 . 5 Aluminium is a metal.

Describe how metals conduct electricity.

Answer in terms of electrons.

[3 marks]

Aluminium have delocalised electrons which carry charge through out the structure

0 1 . 6 Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

Ionic

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0 1 . 7 Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen.

Describe what happens when a magnesium atom reacts with an oxygen atom.

You should refer to electrons in your answer.

[4 marks]

Magnesium atom loses 2 electrons while Oxygen gains 2 electrons forming a negative ion.
Magnesium ion is attracted to oxygen ion forming Magnesium oxide

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0 2 Sodium carbonate reacts with hydrochloric acid in an exothermic reaction.

The equation for the reaction is:

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

A student investigated the effect of changing the mass of sodium carbonate powder on the highest temperature reached by the reaction mixture.

0 2 . 1 Plan a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached.

[6 marks]

Measure different masses of sodium Carbonate powder eg 5g, 10g and 15g.
Measure equal volumes of hydrochloric acid and transfer to polystrene cups.
Measure their initial temperature using a thermometer
Add the mass into the polystrene cup, stir and measure the maximum temperature.

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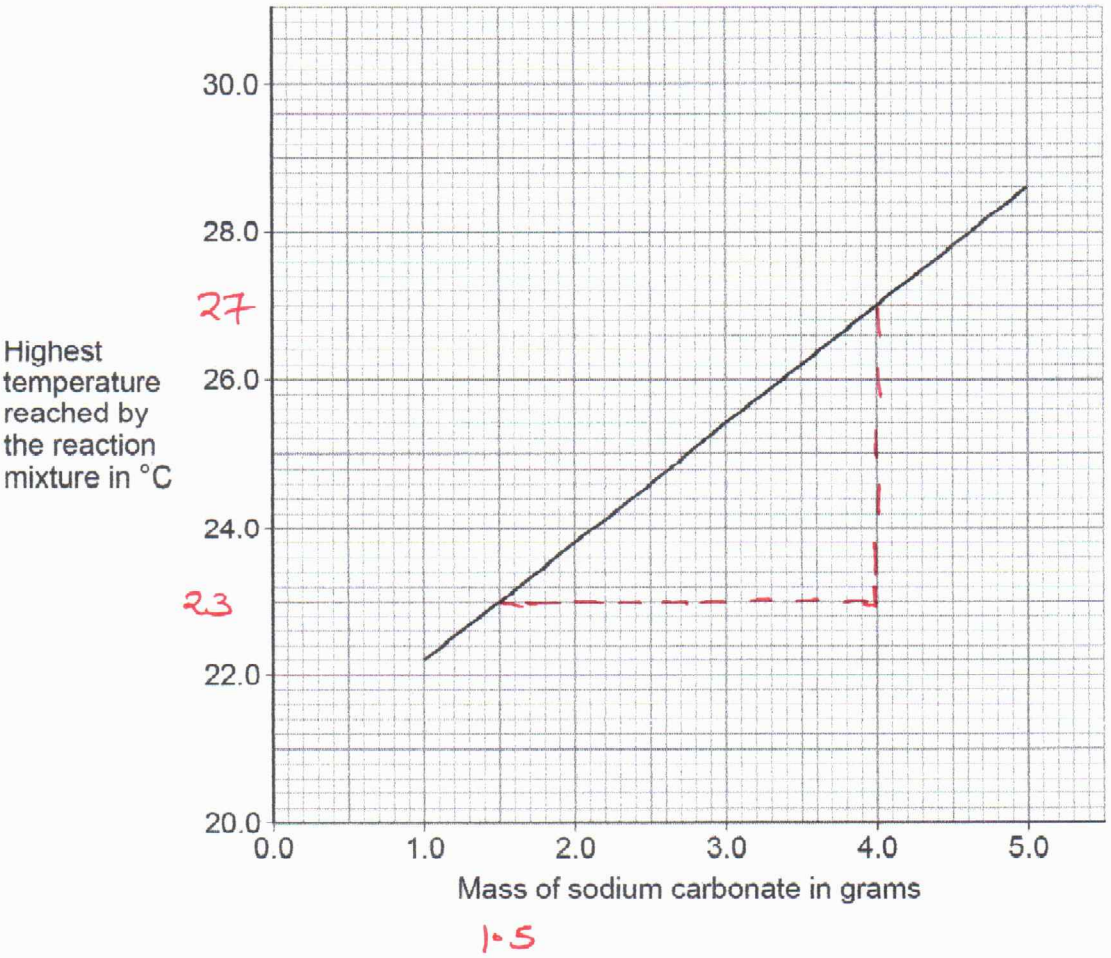
Figure 3 shows a line of best fit drawn through the student's results.

Figure 3



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0 2 . 2 Determine the gradient of the line of best fit in **Figure 3**.

Use the equation:

$$\text{Gradient} = \frac{\text{Change in highest temperature}}{\text{Change in mass}}$$

Give the unit.

[5 marks]

Gradient $= \frac{(27 - 23)\,^{\circ}C}{(4.0 - 1.5)\,g}$

Gradient = 1.6 Unit °C/g

0 2 . 3 The initial temperature of the reaction mixture is where the line of best fit would meet the *y*-axis.

Determine the initial temperature of the reaction mixture.

Show your working on **Figure 3**.

[2 marks]

Initial temperature of the reaction mixture = 20.6 °C

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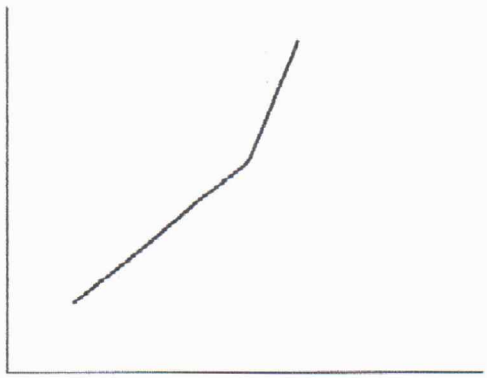
0 2 . 4 Another student repeated the investigation but added sodium carbonate until the sodium carbonate was in excess.

Which sketch graph shows the results obtained when sodium carbonate was added until in excess?

[1 mark]

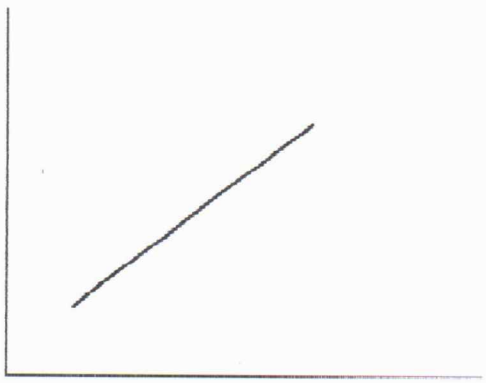
Tick (✓) **one** box.

A



☐

B



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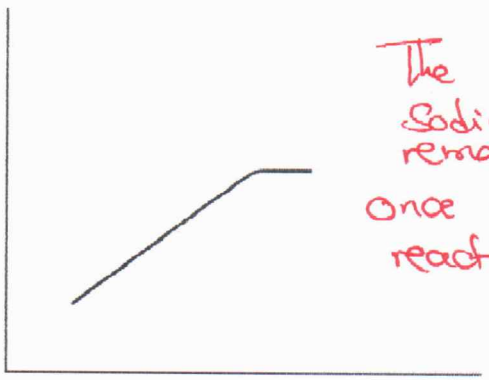
C



The mass of Sodium Carbonate remains the same once the reaction has stopped

☐

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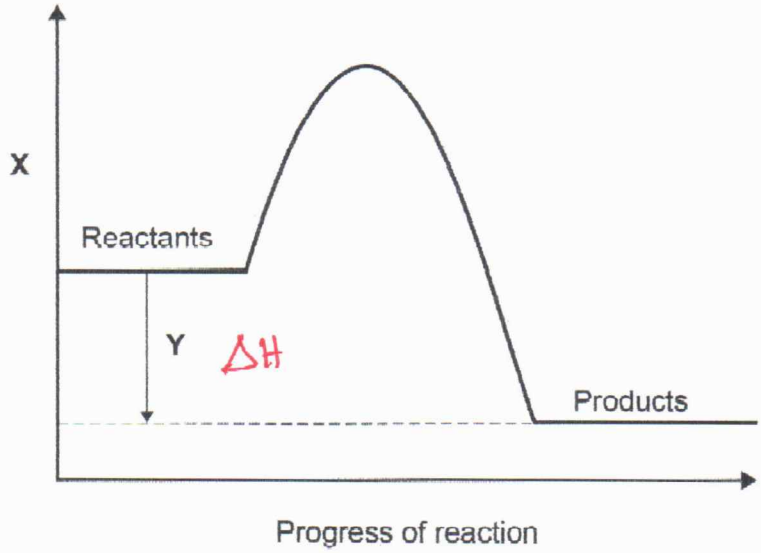
Do not write outside the box

Figure 4 shows a reaction profile for the reaction of sodium carbonate with hydrochloric acid.

Figure 4



0 2 . 5 What do labels **X** and **Y** represent on **Figure 4**?

[2 marks]

X Energy.

Y Energy change

0 2 . 6 How does the reaction profile show that the reaction is exothermic?

Use **Figure 4**.

[1 mark]

The products are below the reactants in terms of energy.

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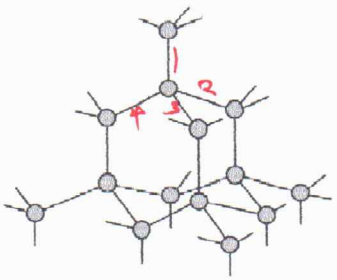
0 3 This question is about different forms of carbon.

Figure 5 represents the structure of diamond.

Figure 5



Key
- Carbon atom

0 3 . 1 Describe the structure and bonding of diamond.

[3 marks]

Carbon atoms are held by covalent bonds forming a giant covalent structure. Each carbon atom is bonded to 4 Carbon atoms.

0 3 . 2 Explain why diamond has a very high melting point.

[3 marks]

The covalent bonds between Carbon atoms in diamond are strong. It needs alot of energy to overcome the forces of attraction.

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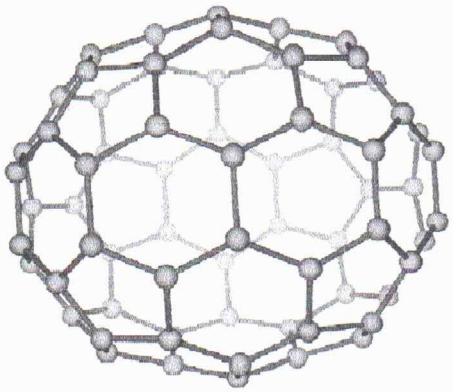
Figure 6 represents the molecule C_{70}

Figure 6



0 3 . 3 What is the name of this type of molecule?

[1 mark]

Tick (✓) **one** box.

- Fullerene ✓
- Graphene
- Nanotube
- Polymer

0 3 . 4 Molecules such as C_{70} can be used in medicine to move drugs around the body.

Suggest **one** reason why the C_{70} molecule is suitable for this use.

[1 mark]

C_{70} is hollow, unreactive and has a large surface area to volume ratio

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Do not write outside the box

0 3 . 5 Calculate the number of C_{70} molecules that can be made from one mole of carbon atoms.

The Avogadro constant = 6.02×10^{23} per mole

[3 marks]

Moles of C_{70} = $\frac{1}{70}$ = 0.0142857

No. of molecules = $0.0142857 \times 6.02 \times 10^{23}$

$= 8.6 \times 10^{21}$

Number of molecules = 8.6×10^{21}

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0 4 This question is about zinc and compounds of zinc.

A student produces pure crystals of zinc chloride by reacting zinc oxide with hydrochloric acid.

The equation for the reaction is:

$$ZnO(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2O(l)$$

0 4 . 1 The student adds zinc oxide to hydrochloric acid until the zinc oxide is in excess.

Give **one** observation that the student could make to show that the zinc oxide is in excess.

[1 mark]

- The solid remains in the beaker

0 4 . 2 Why is excess zinc oxide used rather than excess hydrochloric acid?

[1 mark]

Zinc oxide can be filtered out

0 4 . 3 Name **one other** compound that the student could add to hydrochloric acid to produce zinc chloride.

[1 mark]

Zinc hydroxide

0 4 . 4 Describe how the student should obtain crystals of zinc chloride from a solution of zinc chloride.

[2 marks]

Heat the solution until crystals start to form. Remove and allow the solution to cool.

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Zinc chloride is also produced in a displacement reaction between zinc and copper chloride solution.

The equation for the reaction is:

$$Zn + CuCl_2 \rightarrow ZnCl_2 + Cu$$

$Zn_{(s)} + Cu^{2+} + 2Cl^- \rightarrow Zn^{2+} + 2Cl^- + Cu$

0 4 . 5 Complete the ionic equation for this reaction.

[1 mark]

$Zn + \underline{\quad Cu^{2+} \quad} \rightarrow Zn^{2+} + \underline{\quad Cu_{(s)} \quad}$

0 4 . 6 Why is zinc described as being oxidised in this reaction?

[1 mark]

Zinc loses 2 electrons.

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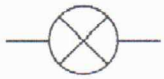
Do not write outside the box

0 4 . 7 Zinc and copper can be used with another substance to produce electricity.

Complete **Figure 7** to show how zinc, copper and another substance can be used to light a lamp.

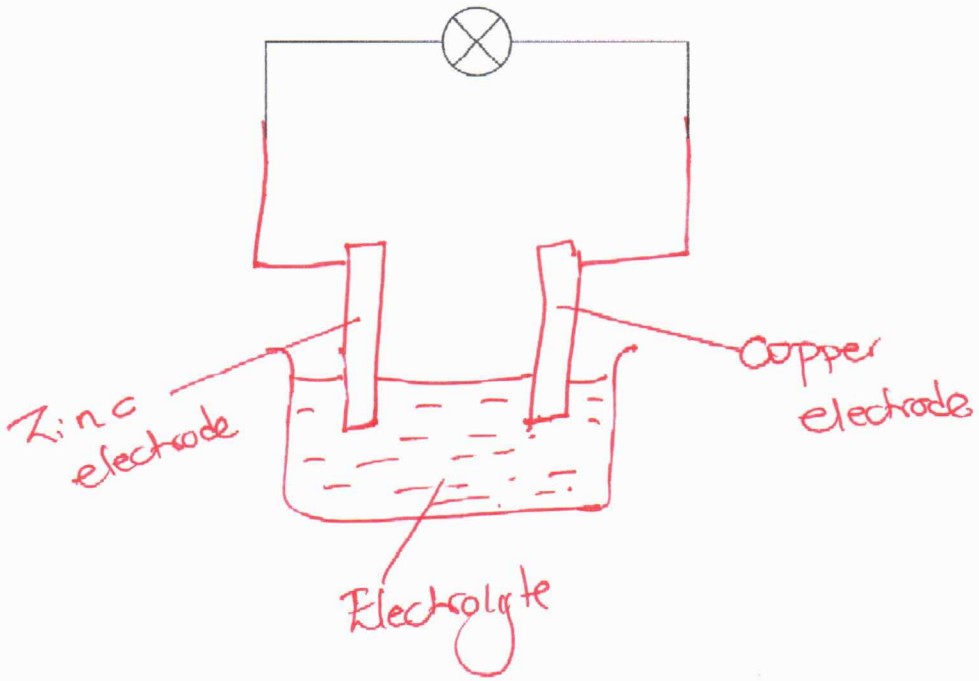
Label:

- zinc
- copper
- the other substance used.

The symbol  represents the lamp.

[3 marks]

Figure 7



10

Turn over for the next question

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0 5 This question is about groups in the periodic table.

The elements in Group 1 become more reactive going down the group.

Rubidium is below potassium in Group 1.

0 5 . 1 Rubidium and potassium are added to water.

Predict **one** observation you would see that shows that rubidium is more reactive than potassium.

[1 mark]

More vigorous bubbling.
Would burst into a bigger flame

0 5 . 2 Explain why rubidium is more reactive than potassium.

[3 marks]

The electron is further from the nucleus, there is less attraction between the nucleus and the outer electron. Its therefore more easily lost

0 5 . 3 Complete the equation for the reaction of rubidium with water.

You should balance the equation.

[3 marks]

$2Rb + 2H_2O \rightarrow 2RbOH + H_2$

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The noble gases are in Group 0.

0 5 . 4 Which is a correct statement about the noble gases?

[1 mark]

Tick (✓) **one** box.

- The noble gases all have atoms with eight electrons in the outer shell. ☐
- The noble gases have boiling points that increase going down the group. ✓
- The noble gases have molecules with two atoms. ☐
- The noble gases react with metals to form ionic compounds. ☐

0 5 . 5 **Table 1** shows information about the three isotopes of neon.

Table 1

Mass number	Percentage abundance (%)
20	90.48
21	0.27
22	9.25

Calculate the relative atomic mass (A_r) of neon.

Give your answer to 3 significant figures.

[3 marks]

$$\frac{(90.48 \times 20) + (21 \times 0.27) + (22 \times 9.25)}{100}$$

$$= 20.1877$$

Relative atomic mass (3 significant figures) = 20.2

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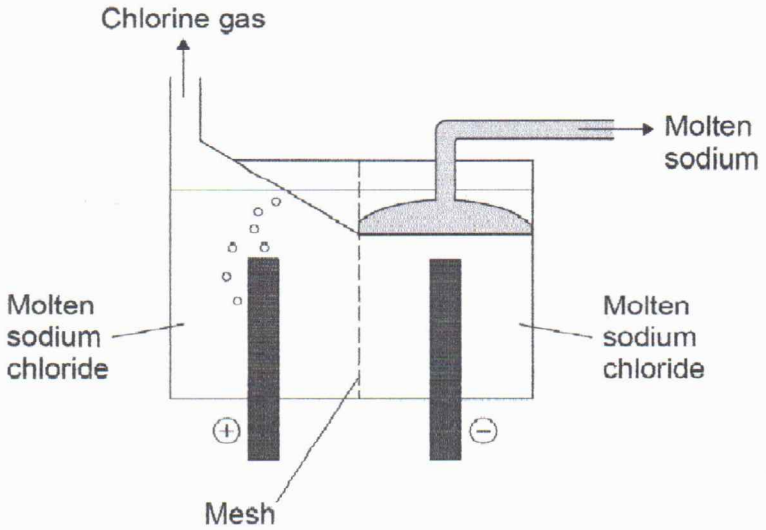
0 6 This question is about electrolysis.

Molten sodium chloride is electrolysed in an industrial process to produce sodium.

Figure 8 shows a simplified version of the electrolysis cell used.

Figure 8



0 6 . 1 Which is the correct half equation for the production of sodium?

[1 mark]

Tick (✓) **one** box.

$Na + e^- \rightarrow Na^+$ ☐

$Na \rightarrow Na^+ + e^-$ ☐

$Na^+ + e^- \rightarrow Na$ ☑

$Na^+ \rightarrow Na + e^-$ ☐

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A mesh is used to keep the products of the electrolysis apart.

0 6 . 2 Suggest **one** reason why the products of the electrolysis must be kept apart.

[1 mark]

So that the products do not react to reform sodium chloride

0 6 . 3 Which type of particle passes through the mesh in the electrolysis of molten sodium chloride?

[1 mark]

Tick (✓) **one** box.

- Atom ☐
- Electron ☐
- Ion ☑
- Molecule ☐

Question 6 continues on the next page

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Do not write outside the box

Aqueous sodium chloride solution is electrolysed in a different industrial process.

Two gases and an alkaline solution are produced.

0 6 . 4 Which **two** ions are present in aqueous sodium chloride solution in addition to sodium ions and chloride ions?

[2 marks]

1 Hydrogen ions

2 Hydroxide ions

0 6 . 5 Name the alkaline solution produced.

[1 mark]

Sodium hydroxide.

0 6 . 6 Explain how the alkaline solution is produced.

You should refer to the processes at the electrodes.

[3 marks]

Hydrogen ions are discharged at the negative electrode to form hydrogen gas. Chloride ions are discharged at the positive electrode to form Chlorine gas. Sodium ions and hydroxide ions are left in solution forming Sodium hydroxide.

9

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0 7 This question is about silicon and compounds of silicon.

0 7 . 1 The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.

Silicon can be extracted by reducing silicon dioxide with different substances.

The equation for one possible reaction is:

$$2C(s) + SiO_2(s) \rightarrow Si(s) + 2CO(g)$$

Explain what this reaction shows about the position of silicon in the reactivity series.

[2 marks]

Silicon is less reactive than carbon. Carbon displaces silicon from silicon dioxide

0 7 . 2 Aluminium also reduces silicon dioxide.

Carbon is used rather than aluminium to reduce silicon dioxide because carbon is cheaper than aluminium.

Carbon can be obtained by heating coal.

Aluminium is obtained from aluminium oxide.

Explain why aluminium is more expensive than carbon.

[2 marks]

More energy is needed to obtain aluminium by electrolysis

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Do not write outside the box

Magnesium also reduces silicon dioxide.

The equation for the reaction is:

$$2\,Mg(s) + SiO_2(s) \rightarrow Si(s) + 2\,MgO(s)$$

0 7 . 3 Give **one** reason why the products are difficult to separate if magnesium is used to reduce silicon dioxide.

[1 mark]

Both products are solids.

0 7 . 4 Calculate the minimum mass in grams of magnesium needed to completely reduce 1.2 kg of silicon dioxide.

Relative atomic masses (A_r): O = 16 Mg = 24 Si = 28

[5 marks]

Mr of silicon dioxide = 28 + (2 × 16) = 60

Mass of silicon dioxide = 1·2 × 1000 = 1200 g.

Moles = $\frac{1200}{60}$ = 20

Moles of Mg = 2 × 20

= 40

Mass of Mg = Moles × Mr.

= 40 × 24

= 960

Minimum mass of magnesium = 960 g

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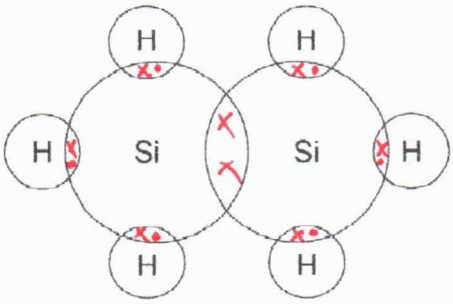
Do not write outside the box

Si_2H_6 is a covalent compound of silicon and hydrogen.

0 7 . 5 Complete **Figure 9** to show the outer shell electrons in a molecule of Si_2H_6

[1 mark]

Figure 9



0 7 . 6 Si_2H_6 reacts with oxygen.

The equation for the reaction is:

$$2\,Si_2H_6(g) + 7\,O_2(g) \rightarrow 4\,SiO_2(s) + 6\,H_2O(g)$$

30 cm^3 of Si_2H_6 is reacted with 150 cm^3 (an excess) of oxygen.

Calculate the total volume of gases present after the reaction.

All volumes of gases are measured at the same temperature and pressure.

[4 marks]

$Si_2H_6 : O_2$

$2 : 7$

30

$= \frac{30 \times 7}{2} = 105 cm^3$

Vol of excess $O_2 = 150 - 105 = 45 cm^3$

Vol of water :- $Si_2H_6 : O_2$

$2 \quad 6$

30

$= \frac{30 \times 6}{2} = 90 cm^3$

Vol of gases $= 45 + 90$

Volume of gases = 135 cm^3

15

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0 8 This question is about acids and alkalis.

0 8 . 1 Explain why the pH of an acid depends on:

- the strength of the acid
- the concentration of the acid.

[4 marks]

pH depends on the concentration of H^+, the higher the concentration of H^+ ions the lower the pH.

The stronger the acid, the greater the dissociation and so the stronger the acid.

The higher the concentration of an acid, the lower the pH

0 8 . 2 A student titrated 25.00 cm^3 of hydrochloric acid with 0.100 mol/dm^3 barium hydroxide solution.

Table 2 shows the results.

Table 2

Titration number	1	2	3	4	5
Volume of barium hydroxide solution used in cm^3	23.90	23.45	23.55	23.55	23.45

The student calculated the volume of barium hydroxide solution to be used in the titration calculation as 23.50 cm^3.

Explain why the student used a volume of 23.50 cm^3 of barium hydroxide solution in the titration calculation.

[2 marks]

Its the mean titre of concordant results.

$$\frac{23.45 + 23.55 + 23.55 + 23.45}{4}$$

$$= 23.50$$

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0 8 . 3 25.00 cm^3 of the hydrochloric acid reacted with 23.50 cm^3 of the 0.100 mol/dm^3 barium hydroxide solution.

The equation for the reaction is:

$$2HCl(aq) + Ba(OH)_2(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

Calculate the concentration of the hydrochloric acid in mol/dm^3.

[4 marks]

Moles of $Ba(OH)_2$

$\frac{23.50}{1000} \times 0.1 = 0.00235$

$Ba(OH)_2 : HCl$

$2 : 1$ $\quad = \frac{0.00235 \times 1}{2} = 0.00470$

0.00235

Concentration $= \frac{\text{moles}}{\text{Volume}}$ $\quad \frac{0.00470}{0.025} = 0.188\ mol\,dm^{-3}$

Volume $= \frac{25}{1000} = 0.025$

Concentration of the hydrochloric acid = 0.188 mol/dm^3

Question 8 continues on the next page

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Another student titrated sulfuric acid with barium hydroxide solution.

The equation for the reaction is:

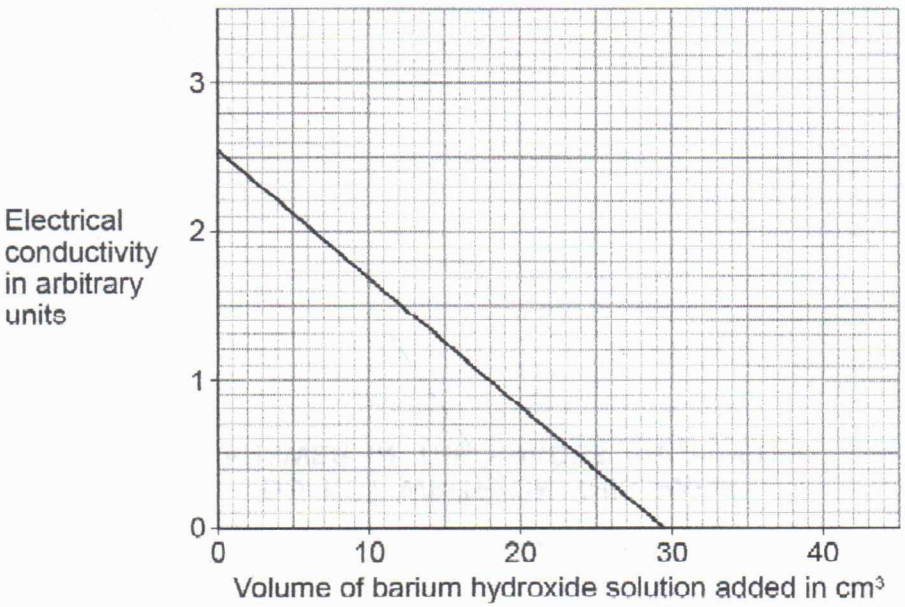
$$H_2SO_4(aq) + Ba(OH)_2(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

The student measured the electrical conductivity of the mixture during the titration.

The better a conductor, the higher the electrical conductivity value.

Figure 10 shows the results.

Figure 10



0 8 . 4 Explain why the electrical conductivity of the mixture was zero when the sulfuric acid had just been neutralised.

Use the equation for the reaction.

Refer to ions in your answer.

[3 marks]

There are no ions that are free to move because barium sulfate is solid and the hydrogen ions have reacted with hydroxide ions to produce water

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Do not write outside the box

0 8 . 5 The student then added a further 10 cm^3 of barium hydroxide solution.

The electrical conductivity of the mixture increased.

Give **one** reason why.

[1 mark]

The mixture then contained barium ions and hydroxide ions that are free to move.

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END OF QUESTIONS